PRINCIPLES OF PLANT TAXONOMY, IV.*

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If the subkingdoms are properly delimited and if one has a knowledge of the general characters and the life histories of plants and if it is evident that a class should be the largest definitely determinable, monophyletic group in a subkingdom, then it becomes possible to establish such groups on a rather substantial foundation. In dividing plants into classes some attention should be given to the practical side of the problem. Each class should stand for some prominent segregative character or group of characters. At present 50 classes are recognized, several of which have only fossil members.

There is some difficulty in finding appropriate names for all the classes. All class names should be descriptive terms ending in *æ*, as Ascomycetæ, Hepaticæ, Coniferæ, Dicotylæ. At present such terms are not available for many of the class groups, and the writer, although originally equipped with a classical education, has up to the present time not found it agreeable to manufacture such names by the wholesale. Generic derivatives and older group names with the ending *eæ* have, therefore, been continued. All terms which necessarily have their endings in *i* or *es* have been discarded, for, as Saccardo pointed out, Ascomycetæ means "Plantæ Ascomycetæ" and it is improper to write the term Ascomycetes unless one is intending to use the English form. But the ending *eæ* is properly a tribe ending and must finally be discarded in class names.

Below, the classes of each subkingdom are segregated and defined, each one being followed by its proper number as it will stand in the phyletic system.

I. PROTOPHYTA. 3000 species. Plants giving no definite indication of a sexual nature.

SCHIZOMYCETÆ (1). Bacteria. 1350 species.

Simple unicellular or filamentous, fission fungi, parasitic, saprophytic or holophytic; non-motile or commonly with flagella or cilia,

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sometimes moving by means of cell contraction; nuclei primitive; often producing non-motile spores which can endure great extremes of heat and cold; cell division in one, two, or three directions; cells not naked nor amoeboid.

MYXOSCHIZOMYCETÆ (2). Slime-bacteria. 24 species.

Unicellular fission fungi with a slight, undulatory motion produced by the contraction of the cell, imbedded in a pesudo-plasmodium and moving about in a mass; forming peculiar sporangium-like bodies when passing into the resting or spore stage; cells not amoeboid. Saprophytes on decaying organic matter, like wood, straw, and manure.

CYANOPHYCEÆ (3). Blue-green Algæ. 1,000 species.

Nonsexual algæ with phycocyanin, blue-green or brownish in color; unicellular, in colonies, plates, or masses, or in simple or branched, undifferentiated or differentiated filaments; cells with simple nuclei and primitive chromatophores; reproduction by simple fission or by hormogones, sometimes with special resting cells; cell wall usually gelatinous. Typically fresh-water plants, frequently occurring in hot springs, some growing in aerial conditions on soil, rocks and trees.

GLAUCOCYSTEÆ (4). Higher Blue-green Algæ. 20 species.

Blue-green algæ with highly differentiated chromatophores and nuclei with nuclear membrane; unicellular or in colonies, the cells dividing in one direction. In water, on submerged Sphagnum, in salt marshes, and on wet limestone.

AUTOSPORÆ (9). Primitive Green Algæ. 200 species.

Simple, nonsexual, green algæ, unicellular, colonial, or filamentous, with reproduction by simple division or usually by autospores; cells normally with one nucleus, the nucleus with nuclear membrane. Mostly fresh-water or aerial plants.

ARCHEMYCETÆ (10). Primitive Fungi. 200 species.

Simple, parasitic, often aquatic fungi without or with a very imperfect filamentous development; nonsexual, with zoospores or with thick-walled resting spores; zoospores usually penetrating into and developing in a cell of the host plant. Commonly growing in pollen-grains in water or in algæ, and occasionally in the leaves, stems, or roots of higher plants.

II. NEMATOPHYTA. 80,000 species. Plants with sexuality, rarely showing a complete loss of this condition, with various types of life cycles, but not with a typical antithetic alternation of generations having a parasitic sporophyte.

ACRASIEÆ (5). Primitive Slime Molds. 10 species.

Saprophytic, unicellular plants without chlorophyll, with an imperfect plasmodium of aggregated cells, the cells not fused together into a continuous mass; zoospores absent, spore masses without a covering wall. Plants showing some resemblance to the Rhizopoda and usually growing on the excrement of animals.

MYXOMYCETÆ (6). Slime Molds. 350 species.

Unicellular, saprophytic, terrestrial fungi with primitive sexuality, occurring in plasmodial masses of more or less completely fused amoeboid cells which finally, with few exceptions, build up complex sporangium-like bodies or fructifications containing the spores; apparently with a simple haploid sexual cycle, the conjugation of nuclei taking place in the plasmodium at the time of the formation of the sporangium, the reduction division at the time of the formation of the resting spores; resting spores on germination giving rise to flagellate or amoeboid cells. Commonly on decaying wood and other dead organic matter.

CHLOROCOCCEÆ (11). 250 species.

Simple, unicellular or colonial, sexual algæ with free zoospores or with ciliated cells united into colonies, usually green in color, but sometimes with other pigments; usually with normal cells containing one nucleus, rarely somewhat cenocytic, the colonial forms not produced by symmetrical aggregation of free zoospores. Reproduction by division, by zoospores and by free-swimming gametes, or by motile spermatozoids and staionary oospheres.

HYDRODICTYEÆ (12). 30 species.

Green cenocytic algæ growing in fresh water, consisting of colonies of peculiar form, often very symmetrical; sexual reproduction by the conjugation of equal motile gametes; nonsexual reproduction by zoospores which form the new colonies by symmetrical aggregation within the walls of the parent cenocyte or which are discharged together, enclosed in a delicate membrane.

DIATOMEÆ (7). Diatoms. 5,700 species.

Single-celled or somewhat filamentous algæ, usually of a brownish color, in which the cell wall becomes silicified and consists of two valves usually with fantastic markings or projections; reproduction by division or by the conjugation of two cells; the nonsexual forms probably degenerate. Marine and fresh-water plants of great abundance.

CONJUGATÆ (8). 2,300 species.

Unicellular or filamentous, normally unbranched and unattached, mostly fresh-water, green algæ with a single nucleus and with one or more highly specialized chloroplasts with pyrenoids in the cells; reproduction by division and by zygospores formed by the conjugation of two similar or nearly similar cells, often joined by the development of a special conjugation tube; aplanospores and parthenospores also frequently present.

SIPHONOCLADEÆ (13). Lower Tube Algæ. 450 species.

Cenocytic, filamentous, mostly septate and attached, green algæ with chloroplasts forming a net or rarely in separate plates; usually branched, isogamous or heterogamous, fresh-water or marine plants.

SIPHONEÆ (14). Higher Tube Algæ. 200 species.

Cenocytic, terrestrial, fresh-water, or marine, green algæ, usually filamentous, simple or branched, usually attached, and usually without

transverse septa in the vegetative parts; reproduction by zoospores, by ciliated gametes, or by true sperms and eggs; chloroplasts distinct, oval, lenticular, or plate-like.

MONOBLEPHARIDEÆ (15). 6 species.

Small, cenocytic fungi with transverse septa, with uniciliated zoospores and with a typical sexual reproduction; saprophytic and aquatic; eggs stationary in the oogonia, which open to admit the free-swimming uniciliated spermatozoids.

CONFERVEÆ (16). Confervas. 650 species.

Simple or branched, filamentous, green algæ having normal cells with one nucleus; sometimes with the cells in disks or sheets; usually attached; reproduction by means of zoospores and by motile iso-gametes or by hetero-gametes, the eggs being stationary; chloroplasts one or more, usually with pyrenoids; mostly growing in fresh water.

PHAEOSPORÆ (17). Little Kelps. 550 species.

Normally brown-colored, marine algæ ranging from quite simple, filamentous forms to rather large organisms, usually attached; reproduction by zoospores produced in unilocular sporangia and by motile gametes produced in plurilocular gametangia; both types of sporangia exposed.

CYCLOSPORÆ (18). Rockweeds. 350 species.

Medium-sized to large, marine, brown algæ; attached, branched, and usually flat or flattish; reproduction by small biciliated sperms and large nonciliated eggs which are discharged and fertilized in the water; reproductive organs sunken in conceptacles; zoospores absent; with a simple diploid sexual cycle.

LAMINARIEÆ (19). Giant Kelps. 100 species.

Large and highly developed, marine, brown algæ, with a distinct conducting tissue whose cells contain sieve-plates; frond usually prominently differentiated into holdfast, stalk, and leathery leaf-like structures; with an alternation of generations, the nonsexual spores (zoospores) produced in unilocular sporangia and giving rise to minute, filamentous, haploid, male and female gametophytes; sporophytes probably diploid; gametangia unilocular.

DICTYOTEÆ (20). 130 species.

Erect, attached, marine, brown algæ with flat leaf-like fronds and with an alternation of generations; nonsexual reproduction by non-motile tetraspores; sexual reproduction by means of non-ciliated eggs, produced singly and finally discharged from the ogonium, and sperms with one flagellum, produced in many-celled antheridia.

MONOSPORÆ (21). 50 species.

Marine or fresh-water, red or purple algæ with filamentous or thalloid fronds; reproduction by single thallus cells and by the production of antheridia and oogonia from ordinary thallus cells, the antheridium developing nonciliated sperms, the oogonium, which is without a distinct trichogyne, usually developing a single, stationary egg.

FLORIDEÆ (22). 3,000 species.

Mostly marine, red or purple algæ, often of considerable size, filamentous or thalloid; reproduction by means of non-ciliated sperms produced in antheridia consisting of definite groups of cells, and eggs produced singly in the base of an oogonium which is prolonged above into a slender trichogyne. Plants with a definite alternation of generations, the fertilized egg having a complicated development, but in the simpler cases giving rise to a juvenile sporophytic body from which one to many carpospores are produced which on germination develop into a second sporophytic stage on which tetraspores are produced, following a reduction division, from which the gametophyte is again propagated.

CHAREÆ (23). Stoneworts. 160 species.

Green, erect, filamentous, mostly fresh-water algæ attached at the base by rhizoids; stems distinctly segmented into nodes and internodes, the nodes being marked by whorls of branches; plants usually with an incrustation of lime and the cells of the stem and branches often covered with a cortical layer of smaller cells; with a simple diploid sexual cycle; oogonia rounded, covered by a cortical layer of spiral branches; antheridia compound and very complex, composed of united branches to form a hollow, globular structure containing sperm-bearing filaments; spermatozoids spirally coiled, biciliated; nonsexual spores absent.

ZYGOMYCETÆ (24). 180 species.

Saprophytic or parasitic fungi with a nonseptate or nearly nonseptate mycelium having a conjugation of equal or nearly equal branches, one of which does not penetrate the other to any extent, the result of the conjugation being a simple or cenocytic zygospore; sometimes parthenogenetic; nonsexual spores nonmotile.

OOMYCETÆ (25). 185 species.

Mostly parasitic fungi with a nonseptate or nearly nonseptate mycelium, with conjugating branches, the one being much larger than the other which penetrates into its interior, or empties its contents into the larger, the result being a simple or cenocytic sexual spore; sometimes parthenogenetic; nonsexual, motile spores also produced which frequently develop in conidia.

ASCOMYCETÆ (26). Sack Fungi. About 18,000 typical species, besides 1,500 Lichens and 13,000 Deuteromycetæ.

Parasitic, helotic, or saprophytic fungi with a septate mycelium, the cells being uninucleate; and with asci usually containing a definite number, often eight, of ascospores, the asci produced as the result of a conjugation of two branches or cells of the mycelium, or apparently commonly through a more complicated sexual process with a binucleate-cell phase or conjugate generation prominently developed and ending in a true diploid nucleus which represents the zygote. The diploid nucleus on dividing undergoes reduction and by subsequent divisions the ascospores are formed; conidiospores commonly developed, in many groups the conidial stage only being known.

LABOULBENIEÆ (27). Beetle Fungi. 500 species.

Minute fungi with a septate body parasitic upon insects, usually beetles, connected with the host by means of a dark-colored, horny base serving as an organ of absorption and a holdfast; oogonium with a slender projection, the trichogyne, to which the nonmotile spermatia became attached and finally fertilize the oosphere below; as the result of fertilization a number of sacs or asci are produced which contain the ascospores.

TELIOSPORÆ (28). Brand Fungi. 4,000 species.

Parasitic fungi with the septate mycelium developed in the tissues of the host, finally producing teliospores which on germinating give rise to septate or nonseptate basidia on which basidiospores are developed; some groups producing five kinds of spores; often heterecious; conjugate phase or generation with binucleate cells prominently developed and often reproducing itself by binucleate spores. Plants especially abundant on species of the grass family.

BASIDIOMYCETÆ (29). Basidium Fungi. 14,000 species.

Mostly large, saprophytic, sometimes parasitic fungi with a septate mycelium; developing septate or nonseptate basidia on the fruiting body or on the vegetative mycelium, not on special teliospores; basidia usually with four spores; conjugate phase prominent and the binucleate cells on dividing developing clamp-connections.

III. BRYOPHYTA. 17,000 species. Nonvascular plants with a continuously dependent sporophyte.

HEPATICÆ (30). Liverworts. 4,000 species.

Gametophyte thalloid or a stem-like frond with scales which are without a costa, mostly dorsiventral, usually with a sack-like envelope, the perigynium, around the archegonia; rhizoids threadlike and unicellular; protonema usually small or only slightly developed, transient. Sporophyte either a spherical sporangium without foot or stalk, or differentiated into a sporangium, foot and elastically elongating stalk; sporangium without columella, usually with elaters, indehiscent, irregularly dehiscent at the top, or splitting into four valves from the summit, rarely developing an operculum.

SPHAGNEÆ (31). Bog-mosses. 380 species.

Gametophyte a stem-like, erect, light, gray-green frond without a true central strand, but with large cortical cells, bearing numerous scales without a costa but with two kinds of cells, narrow ones with chlorophyll and large ones without, but commonly with holes in the walls and with spiral fibrils; rhizoids septate; protonema finally thalloid and flat; fruiting plant developing one or more pseudopodia which support the stemless sporophytes. Sporophyte with an expanded foot; sporangium with a shallow, dome-shaped spore-cavity in the upper part and with an operculum but without a peristome, elaters, or air cavities. Growing in bogs and wet places.

SCHIZOCARPÆ (32). Granite-mosses. 105 species.

Gametophyte a stem-like, erect frond without a central strand, bearing numerous scales without or with a costa; rhizoids consisting of cylindrical masses or plates of cells; protonema more or less thalloid. Sporophyte without a seta, but with a foot and finally carried upon a pseudopodium; sporangium without air cavities, splitting into four or more valves which are at first united at the top; spore-cavity cylindrical dome-shaped with an upward projecting central columella; elaters none; calyptra present on the sporophyte. Caespitose plants of a dark brown color growing on rocks.

ODONTOCARPÆ (Musci) (33). Mosses. 12,500 species.

Gametophyte a stem-like, erect or prostrate frond, usually with a well-developed central strand and usually with costate scales; rhizoids filamentous, septate; protonema usually well-developed and filamentous, sometimes persistent; psedopodium none. Sporophyte well-developed, with sporangium, foot, and usually with a well-developed hypophysis, and a seta with a central strand; sporangium usually with an operculum and a central columella extending entirely through the spore cavity, usually with a well-developed peristome and air spaces often communicating on the outside with true stomata; venter of the archegonium enlarging and usually ruptured at the base, the upper part being carried on top of the sporangium as the calyptra.

ANTHOCEROTÆ (34). Hornworts. 105 species.

Gametophyte a dorsiventral, thalloid frond without scales or with imperfectly developed scales but with unicellular rhizoids; sexual organs imbedded in the tissue of the thallus; protonema small and transient. Sporophyte with a slender horn-like or pod-like sporangium and with a bulbous foot containing an irregular surface with wart-like projections; sporangium with a central columella, two-valved, with small irregular elaters among the spores; epidermis with or without stomata; cells mostly with a single large chloroplast; intercalary growth present between the foot and sporangium.

IV. PTERIDOPHYTA HOMOSPORÆ. 7000 species. Homosporous vascular plants in which the sex is determined in a haploid cell of the gametophyte.

PHYLLOPTERIDÆ (Filices) (35). Ferns. 6500 species.

Sporophyte herbaceous or tree-like, indeterminate in growth, usually with a horizontal, simple or branched rhizome; leaves usually large, spirally arranged, and mostly compound, rarely narrow and grass-like; sporangia borne on the underside of the leaf, or on the morphologically upper side on simple or branched sporangiophores; eusporangiate or leptosporangiate, with or without indusia; sporophylls never in cones. Gametophyte comparatively large, tuber-like, without chlorophyll and subterranean, or usually developed as a flat, simple or rarely branched thallus, usually hermaphroditic but unisexual in some of the higher forms; spermatozoids multiciliate.

SPHENOPHYLLEÆ (38). Fossil.

Paleozoic plants of moderate dimensions with solid, jointed stems with a central, triarch vascular bundle; leaves mostly wedge-shaped, comparatively small; sporophylls in cones.

EQUISETEÆ (39). Horsetails. 25 species.

Sporophyte perennial, herbaceous, with a rhizome and with jointed, mostly hollow, simple or branched, annual or perennial, aerial stems; vascular bundles in a circle; leaves reduced to sheaths around the joints, the sheaths toothed; cones terminal with small peltate sporophylls arranged in whorls; sporangia sack-like, eusporangiate; lowest whorl of the cone of united segments developing sporangia on the upper side in the lower species but forming a sterile calyx in the highest; spores with 4 narrow, strap-like, spiral, hygroscopic appendages formed from the outer wall. Gametophyte a small green thallus hermaphroditic or unisexual with frequent sex-reversal; spermatozoids multiciliate.

LYCOPODIEÆ (41). Lycopods. 160 species.

Sporophyte perennial, herbaceous, with or without a rhizome the aerial stems upright or trailing; branching dichotomous; leaves small, without a ligule, spirally arranged on the stem, two-to many-ranked; sporangia solitary on the upper surface of the leaves or in their axils, sometimes trilocular, eusporangiate; sporophylls in bands or zones alternating with the foliage leaves or arranged in terminal cones; spores small, not appendaged. Gametophyte small, sometimes subterranean, with or without chlorophyll, hermaphroditic; spermatozoids small, biciliate.

V. PTERIDOPHYTA HETEROSPORÆ. 800 species. Seedless plants with two kinds of nonsexual spores, the sex being determined in a diploid cell of the sporophyte.

ISOETEÆ (36). Quillworts. 64 species.

Sporophyte with a short, tuberous stem with a peculiar type of secondary thickening and with long, erect, grass-like leaves which have a ligule; roots dichotomous; microsporangia and megasporangia large, borne singly, sunken in the upper side of the expanded bases of the leaves, eusporangiate. Gametophytes very much reduced, unisexual; spermatozoids large, spirally coiled, multiciliate.

HYDROPTERIDÆ (37). Water-ferns. 75 species.

Sporophytes small with a horizontal rhizome or floating on the surface of the water; leaves alternate or whorled; internodes mostly well-developed; microsporangia and megasporangia borne together on the same leaf, enclosed in true sporocarps or apparent sporocarps, leptosporangiate. Gametophytes developing entirely within the spore walls or protruding only slightly, very short-lived; spermatozoids large spirally coiled, multiciliate.

CALAMARIÆ (40). Calamites. Fossil.

Paleozoic plants, sometimes of tree-like aspect and dimensions, with hollow, jointed stems and with a circle of colateral bundles; stems increasing in diameter by a cambium zone; heterosporous, the sporophylls in cones.

SELAGINELLEÆ (42). Selaginellas. 600 living species.

Small herbs or many of the fossil forms large trees. Sporophytes of living species erect, or ascending, or sometimes creeping and dorsiventral, with dichotomous stems and dichotomous roots; leaves small spirally arranged or sometimes opposite, ligulate; cells often with a single chloroplast; sporophylls in bisporangiate cones, the eusporangiate microsporangia and megasporangia single on the base of the upper side of the sporophylls. Gametophytes minute and short-lived; spermatozoids minute, biciliate. Some fossil species developed into large trees with secondary thickening by a cortical meristem and with a dichotomous branching system developed at the base as well as at the top of the stem, apparently being the first sporophytes with a successful basal growth.

VI. GYMNOSPERMÆ. 500 living species. Seed plants with open carpels.

PTERIDOSPERMÆ (43). Fossil.

Paleozoic seed-plants of fern-like aspect; stems short and usually erect, increasing in thickness and bearing mostly compound leaves.

CYCADEÆ (44). Cycads. 95 living species.

Sporophyte with erect, often woody, simple or little-branched stems or occasionally geophilous, bearing compound leaves; vascular bundles collateral, increasing in thickness by their cambiums; cortical meristems developed in some species in which new circles of bundles are produced; sporophylls in cones or the carpels sometimes merely in zones through which the stem grows; living species diecious; ovules with pollen-chambers; embryo with 2 cotyledons, rarely one. Female gametophyte becoming large and fleshy; male gametophyte, or pollengrain developing two or more large, spirally coiled and multiciliate spermatozoids.

CORDAITEÆ (45). Fossil.

Paleozoic, sparsely branched trees bearing large, long, parallel-veined leaves spirally arranged.

GINKGOÆ (46). Maiden-hair-trees. 1 living species.

Sporophytes developing into large trees with a cambium layer from which annual rings of wood are produced, with a crown of numerous branches of two types, long branches with internodes and dwarf branches without, with spirally arranged, broad, dichotomously veined, deciduous leaves, and without flowers but with zones of sporophylls on some of the dwarf branches; ovule with pollen-chamber; cotyledons 2, the embryo sometimes not developing until the seed drops to the ground. Female gametophyte becoming large in the seed which has a bony inner and a fleshy outer coat; male gametophyte developing 2 large, spirally coiled, multiciliate spermatozoids.

CONIFERÆ (47). Conifers. 350 species.

Sporophytes developing as large trees or shrubs, much branched, with or without dwarf branches; stems with a normal cambium, no vessels in the secondary wood, resin commonly present; leaves mostly small, scale-like, linear, or needle-like, rarely broad; flowers monosporangiate, monecious or diecious, the higher types much reduced; cotyledons 2-15; ovule without pollen-chamber. Female gametophyte usually comparatively small; pollengrains sometimes winged, producing two non-motile sperms.

GNETEÆ (48). 50 species.

Sporophytes developing as shrubs or lianas, or rarely as trees, with branched or rarely simple stems; secondary wood containing vessels representing enlarged tracheids; leaves simple, opposite or whorled, sometimes reduced to dry bracts but often large; flowers monecious or mainly diecious, collected in specialized inflorescences; resin passages none; cotyledons two. Gametophytes small, various in character, the sperms not motile.

VII. ANGIOSPERMÆ. 150,000 species. Seed plants with closed carpels and with stigmas; xeniophyte usually present.

MONOCOTYLÆ (49). Monocotyls. 25,000 species.

Sporophytes developing as herbs or sometimes as woody plants of large dimensions; embryo usually with one terminal cotyledon and usually with a lateral plumule; stem with closed, usually scattered vascular bundles, without typical bark and without annual rings of growth, rarely with secondary thickening; leaves mostly parallel-veined, sometimes netted-veined; flowers mostly of the trimerous and typically of the pentacyclic type.

DICOTYLÆ (50). Dicotyls. 125,000 species.

Sporophytes developing as herbs or woody plants; embryo with two cotyledons, rarely with more or with only one, and with a terminal plumule; stem with open vascular bundles, usually arranged in a circle and developing a continous cambium cylinder, forming annual rings of growth in the case of perennial stems, with bark on the outside; leaves usually netted veined; flowers more commonly pentamerous or tetramerons, the higher types usually tetracyclic.

SYNOPSIS OF THE PLANT PHYLA AND SUB-PHYLA.

It is possible, in a vague way, to see monophyletic relationships among certain classes. These apparently related classes can then be combined into convenient larger groups, the Phyla. The phyla represent the largest taxonomic groups.

In establishing phyla, regard should be had for convenience and practical usability as in the case of the classes. Most

systematists would probably agree that all the META-THALLOPHYTA are monophyletic as compared with the THALLOPHYTA. This is no reason, however, for establishing such a complex system as a single phylum in contrast to numerous phyla in the Thallophyta as is sometimes done. It is evident that from the evolutionary point of view, all the Thallophyta have also come from a common source and are in this sense monophyletic. The aim should be to segregate great branches or groups of somewhat similar value and importance. It seems to the writer that about 15 main groups will make a satisfactory system, although he has no quarrel with any one who thinks there should be several more, so long as the groups are practical and of more or less equal value.

I. Plant body unicellular, colonial, or multicellular, frequently filamentous; ovary when present never an archegonium; nonsexual plants or with a simple haploid or a simple diploid sexual cycle, sometimes with haploid and conjugate phases, the conjugate phase with binucleate cells, sometimes with an alternation of haploid and diploid generations, but then not of the typical antithetic type, the diploid sporophyte never having a parasitic existence or proper parasitic phase on the parent gametophyte, but originating from a free spore or zygote.....(THALLOPHYTA).

A. Cells typically with poorly differentiated nuclei and chromatophores and with a primitive type of nuclear division; motile or nonmotile, with or without chlorophyll, never with a pure chlorophyll-green color; reproduction by fission; resting spores or cells commonly present.....Phylum I. SCHIZOPHYTA. 1, 2, 3, 4.

B. Cells with well differentiated nuclei and if holophytic usually with definite chloroplasts; with or without chlorophyll; plants green or colorless or variously tinted by coloring matter other than chlorophyll.

(A). Unicellular saprophytic plants without chlorophyll, having a plasmodium stage of more or less completely fused cells, mostly amoeboid in nature, from which complex sporangium-like resting bodies are built up; sexuality primitive, consisting of the conjugation of nuclei in the plasmodium at the time the sporangia develop; resting spores finally liberating flagellate or amoeboid cells.....Phylum II. MYXOPHYTA. 5, 6.

(B). Plants not developing a plasmodium, the cells usually covered with a wall during the vegetative phase.

1. Unicellular or filamentous plants containing chlorophyll, either brown and with silicious, two-valved walls or green with complex chromatophores and the walls not silicified; conjugating cells not ciliated, isogamous; with a simple haploid sexual cycle, the reduction division probably always in the zygote.....Phyllum III. ZYGOPHYTA.

a. With silicified cell walls and brown coloring matter. Subphylum and class 1.....DIATOMEÆ. 7.

b. Not with silicified walls; cells green. Subphylum and class 2.....CONJUGATÆ. 8.

2. Plants not with silicified two-valved walls; either nonsexual or isogamous or heterogamous; if with a direct conjugation of walled cells or branches then without chlorophyll.
   (1). Plants with chlorophyll, or if without chlorophyll, then either without a true mycelium, or if a mycelium-like filament is present then with a sexual phase with ciliated, motile spermatozoids and stationary eggs.
      a. Antheridium when present not consisting of a globular structure containing sperm-bearing filaments.
         (a). Plants usually green, with chlorophyll or colorless, nearly all producing nonsexual zoospores; unicellular, colonial, or multicellular, nonsexual or mostly sexual plants, the sexual forms isogamous or heterogamous; nearly all with simple, haploid, sexual cycle, but some apparently with a simple, diploid, sexual cycle.
            Phylum IV. GONIDIOPHYTA. 9, 10, 11, 12, 13, 14, 15, 16.
         (b). Plants with the chlorophyll usually hidden by a brown, red, or purple pigment, always with a multicellular body and sexuality.
            ((a)). Mostly marine brown algæ with phycophaein; isogamous or heterogamous with ciliated sperms, both gametes usually discharged from the gametangia; with a simple, diploid, sexual cycle, perhaps some also with a simple, haploid sexual cycle, or in the higher forms with two or more types of the alternation of generations cycle.
               Phylum V. PHAEOPHYTA. 17, 18, 19, 20.
            ((b)). Mostly marine red or purple algæ with phyco-erythrin; heterogamous, with stationary eggs and nonciliated sperms; apparently normally with an alternation of generations.
               Phylum VI. RHODOPHYTA. 21, 22.
      b. Filamentous, aquatic, green algæ with globular antheridia containing sperm-bearing filaments, the sperms being biciliated; nonsexual spores absent; with a simple, diploid, sexual cycle, the reduction division apparently taking place in the sexual organs.
         Phylum VII. CHAROPHYTA. 23.
   (2). Plants without chlorophyll and with a true septate or nonseptate mycelium; sexual reproduction without motile sperms; nonsexual reproduction of various types; with a simple, haploid, sexual life cycle, or in the higher forms with a modification of this cycle, in which a binucleate or conjugate phase follows the normal haploid phase with uninucleate cells.....Phylum VIII. MYCOPHYTA.
      a. Mycelium cenocytic; without ascospores or basidiospores.....Subphylum I. PHYCOMYCETÆ. 24, 25.
      b. Mycelium normally not cenocytic, with ascospores or basidiospores, or apparently numerous degenerate forms in which such spores are no longer developed, but which are propagated solely by conidia.
         Subphylum 2. MYCOMYCETÆ. 26, 27, 28, 29.

II. Plant body a solid aggregate; if filamentous, only so in the embryonic or immature condition; ovary a typical archegonium or if much reduced then the plants seed-bearing; always with a typical, antithetic alternation of generations in the normal life cycle, the diploid sporophyte being parasitic during its entire life or in its embryonic phase on the sporophyte.
   (META-THALLOPHYTA).

A. Without vascular tissue; sporophyte parasitic on the gametophyte during its entire life and determinate in growth; homosporous; small plants without roots or true leaves.
Phylum IX. BRYOPHYTA. 30, 31, 32, 33, 34.

B. Always with vascular tissue in the sporophyte which becomes an independent plant, after the embryonic phase, with roots and leaves except in a few degenerate forms; and always with decidedly indeterminate growth of all or part of the axes.

(A). Sporophyte not seed-producing; sperms breaking out of the antheridium to enter the necks of the archegonia directly; homosporous or heterosporous, the sex being determined either in the gametophyte or in the sporophyte.

1. Spermatozoids comparative large and multiciliate; sporophylls not in cones, or in cones (strobili or primitive flowers), but then the sporophyte with jointed stems and whorled leaves; branching normally monopodial.
   a. Stems not jointed, the leaves usually large and compound and spirally arranged, rarely in whorles; sporophylls never in cones, the reproductive axes always indeterminate.....Phylum X. PTENOPHYTA. 35, 36, 37.
   b. Stems jointed and fluted, bearing whorled leaves, which in living forms and in most fossil forms are much reduced; sporophylls in cones; living species, and many fossil forms also, with some determinate vegetative branches.
   Phylum XI. CALAMOPHYTA. 38, 39, 40.
2. Spermatozoids small, biciliate; leaves of the living species small, covering the continuous stem in spirals, or sometimes in opposite arrangement; rarely with a slight internodal development; branching of the stem dichotomous, the lowest species all indeterminate; sporophylls usually in cones or in the lower forms in zones alternating with the sterile leaves; frequently also with determinate vegetative branches.
Phylum XII. LEPIDOPHYTA. 41, 42.

(B). Sporophyte producing seeds, the female gametophyte always parasitic in the megasporangium (ovule) during its entire life, the male gametophyte developing a pollen-tube through which the sperms are discharged, hence with a two-phased parasitic growth, the first stage in the microsporangium, the second in the ovule, or in the higher groups beginning in the tissues of the megasporophyll itself (carpel); with a resting stage intercalated between the two phases of the sporophyte; always heterosporous; the sex being determined in the sporophyte.

1. Carpels open, without stigmas or true ovularies, the ovules and seeds naked and the pollen-grains (male gametophytes) falling directly into the micropyle; no true endosperm or xeniophyte present.
   a. Sperms so far as known ciliated and motile; ovules with a pollen-chamber; with or without flowers, the sporophylls either being in cones, or in rosettes on indeterminate axes.
   Phylum XIII. CYCADOPHYTA. 43, 44, 45, 46.
   b. Sperms without cilia; ovules without pollen-chambers; sporophylls in cones, which may be highly specialized or reduced and in the highest types collected into definite inflorescences; woody plants, monecious or diecious.
   Phylum XIV. STROBILOPHYTA. 47, 48.
2. Carpels or the set of carpels closed at maturity, with stigmas and with ovularies enclosing the ovules and seeds; pollen-grains falling on the stigma and developing long pollen-tubes; flowers well developed, commonly with a perianth, often highly specialized or reduced; true endosperm or xeniophyte normally present.....Phylum XV. ANTHOPHYTA. 49, 50.

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